



(19) Europäisches Patentamt  
European Patent Office  
Office européen des brevets



(11) EP 0 997 358 A2

(12)

## EUROPEAN PATENT APPLICATION

(43) Date of publication:  
03.05.2000 Bulletin 2000/18

(51) Int. Cl.<sup>7</sup>: B60R 22/48, B60R 22/12

(21) Application number: 99202589.0

(22) Date of filing: 06.08.1999

(84) Designated Contracting States:  
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU  
MC NL PT SE  
Designated Extension States:  
AL LT LV MK RO SI

(30) Priority: 29.10.1998 US 182852

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### (54) Safety belt with load sensor

(57) A load sensor (24) for a vehicle safety belt (10) comprises means for determining an electrical characteristic of the belt and control means for comparing the sensed characteristic with a reference level for the characteristic. In one embodiment, conductive fibers (26, 28) are interwoven into the belt and electrical contacts (30, 32) are provided at each end 20 thereof. Excessive loading of the belt results in a break in the fibres which, in turn, results in electrical discontinuity. The discontinuity is sensed by an electrical sensor and indicator means is provided to indicate to the driver of the vehicle that a belt has been excessively loaded.

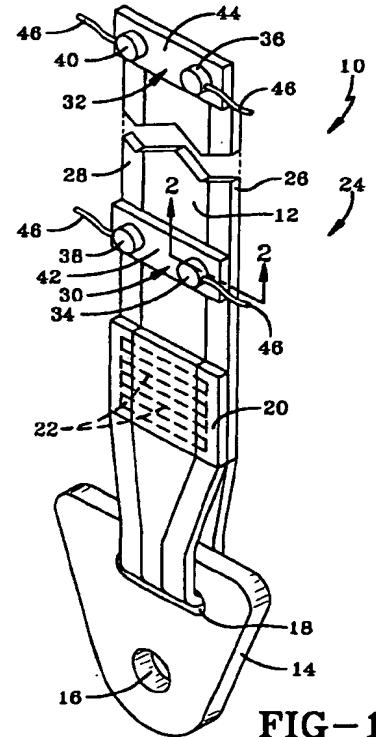


FIG-1

## Description

[0001] The present invention relates to a sensor for sensing the load applied to a vehicle safety belt and a vehicle safety belt apparatus incorporating such a sensor. Safety belts are used in most motor vehicles for restraining vehicle occupants and/or cargo in position in the event of hard braking or a crash.

[0002] It is an object of the present invention to provide a sensor for sensing the load applied to vehicle safety belts. This object is achieved by a device having the attributes set forth in the characterising portion of claim 1.

[0003] Embodiments of the invention will now be described in detail and with reference to the accompanying drawings in which:

FIG. 1 is a perspective view of a safety belt in accordance with the invention having a load sensor in accordance with the invention,

FIG. 2 is a section through part of the belt of FIG. 1,

FIG. 3 is a perspective view of part of a safety belt in accordance with the invention having a load sensor in accordance with the invention.

FIG. 4 is a circuit diagram of a load sensor in accordance with the invention and,

FIG. 5 is a schematic illustration of a safety belt in accordance with the invention having a load sensor in accordance with the invention.

[0004] In FIG. 1, a safety belt 10 comprises an elongate strip of flexible webbing material 12 which is secured in the vehicle by means of a bracket 14. The bracket has an aperture 16 for receiving a bolt (not shown) for securing the bracket to the vehicle and a slot 18 through which the end 20 of the belt 12 passes. The end 20 is folded back against part of the belt and the belt is secured against pulling out of the bracket by the end 20 being sewn to the part of the belt against which it is folded back. Stitching 22 that secures the end 20 against the belt 12 is sufficiently strong to secure against loads normally experienced by vehicle safety restraint belts. A load sensor 24 includes a first set of conductive fibres 26 interwoven with the webbing of the belt along one edge thereof and extending longitudinally of the belt, a second set of conductive fibres 28 interwoven with the webbing of the belt along the other edge thereof and extending longitudinally of the belt and electrical contact members 30, 32 at opposite ends of the belt. Each contact member 30, 32 comprises respective first contact pins 34, 36 for contacting opposite ends of the first set of conductive fibres 26 and respective second contact pins 38, 40 for contacting opposite ends of the second set of conductive fibres 28. The respective

5 first and second contact pins 34, 38 and 36, 40 are connected by respective straps 42, 44 of insulating material. Each contact pin is electrically connected to a control circuit by means of leads 46. FIG. 2 illustrates the connection of the contact pin 34 with the conductive fibres 26. The pin 34 extends through the strap 42 of insulating material and through the fibres 26 to form an electrical contact therewith.

[0005] FIG. 3 shows an alternative embodiment of a safety belt in which the belt is wound on to an inertia reel 48. Such devices are well known in the art of safety belt technology. In the embodiment shown in FIG. 3 the safety belt 12 is substantially similar to that shown in FIG. 1 in that it includes conductive fibres 26, 28 interwoven into the webbing of the belt 12 at each edge thereof and extending longitudinally thereof. The electrical contacts in the case of the FIG. 3 belt are made with each set of fibres by respective sets of conductive brushes 50, 52 mounted to the mouth 54 of the inertia reel 48. The brushes 50, 52 are connected to the control circuit by means of leads 46. The other end (not shown) of the belt in FIG. 3 may include a contact member 30 similar to that shown in FIG. 1.

[0006] During normal usage, safety belts are loaded under tension and there is a possibility that a safety belt may be excessively loaded when used to restrain a vehicle occupant or cargo under hard braking or in the event of a crash. In the event of hard braking or a crash the safety belt may be loaded excessively with the result that the safety belt may not perform adequately in future emergencies.

[0007] With the safety belts of FIGS. 1 and 3 the electrical characteristics of the conductive fibres 26, 28 are sensed and an excessive loading of the safety belt 35 will result in a change in those electrical characteristics. In particular, it is proposed to use carbon fibres as the conductive fibres. Carbon fibres are relatively brittle in comparison to the webbing of the safety belt and in the event of excessive loading, the carbon fibres will break 40 causing an electrical discontinuity. That discontinuity can be detected by the load sensor 24 and the excessive loading of the safety belt brought to the attention of the driver by illuminating an indicator light on the vehicle control panel. Alternatively, metal fibres could be used 45 which may or may not break due to excessive loading, but the strain placed upon the fibres due to excessive loading of the safety belt will result in a change in their electrical resistance which can be detected by the load sensor 24 in the manner of a strain gauge, to determine 50 that the safety belt has been excessively loaded.

[0008] In the embodiment shown in FIGS. 1 and 3, separate electrical contacts are provided for each set of conductive fibres. In that way, each edge of the safety belt is provided with a respective load sensor. However, it will be appreciated that as an alternative to the separate electrical contacts at the end spaced from the contact member 30, a conductive bridge piece (not shown) 55 may be provided to link the respective sets of fibres

electrically at the end spaced from the contact member 30. In that way, a single electrical circuit is provided and the load sensor 24 detects changes in the electrical characteristics of both sets of conductive fibres with one contact member 30. For example, instead of the contact member 32, a conductive strap may be attached from one set of fibres 26 to the other set 28.

[0009] FIG. 4 is a schematic illustration of an example of a circuit diagram of a load sensor 24 that may be used to determine excessive loading of a safety belt 12. In FIG. 4 a power supply, for example the vehicle battery, powers the load sensor arrangement. The circuit is connected downstream of the vehicle ignition and on ignition a switch 56 is closed. On ignition, a current flows via a timer 58 and an indicator lamp 60 on the vehicle control panel to earth, illuminating the lamp for a predetermined period of time in order to test the lamp. After the predetermined period of time has elapsed, the timer 58 switches the current to the control circuit of the load sensor 24. In that arrangement, the first set of conductive fibres 26 and the second set of conductive fibres 28 are linked at one end by a conductive bridge 62. The other ends of the fibres 26, 28 are connected to a contact member 30 as shown in FIG. 1. The lead 46 from the first contact pin 34 powers a relay 64. The lead 46 from the second contact pin 36 is connected via relay 64 to the lamp 60. Thus, in use, when the vehicle ignition is switched on, the lamp 60 is powered for a short time until the timer 58 switches the current to the control circuit of the load sensor 24. If the safety belt 12 is in acceptable condition, then the relay 64 remains closed and the current passes to earth via the lead 46 from the contact pin 34. If the conductive fibres are broken due to an excessive loading of the safety belt, then the power to the relay 64 from the contact pin 34 is disconnected allowing the switch in the relay to be opened so that current can pass to the lamp 60. Thus, if the webbing of the safety belt 12 is not in acceptable condition, the lamp 60 will remain on after the predetermined period of test time set by the timer 58 which will alert the driver of the vehicle to the fact that one of the safety belts is defective.

[0010] On the display panel of the vehicle instrument panel, respective lamps may be provided for each safety belt and a diagram of the vehicle may be superimposed so that the driver can identify which safety belt is defective.

[0011] FIG. 5 is a schematic diagram illustrating a further embodiment of a safety belt load sensor in accordance with the invention. In that embodiment, a safety belt 12 has a first electrical contact 66 at one end of the safety belt and a second electrical contact 68 at the other end of the safety belt. An electrical characteristic sensor 70 is connected between the contacts 66, 68. The electrical characteristic sensor could sense the potential difference between the contacts the resistance between the contacts or the capacitance of the safety belt 12 between the contacts. The sensed characteristic

is measured by the sensor 70 and that data is passed to a central processing unit 72 such as a microprocessor, for example, a vehicle diagnostic computer. The microprocessor records the initial value of the electrical characteristic, for example capacitance, and may define an error range around that initial value in order to provide a calibrated value of each vehicle safety belt for each journey. If the safety belt is excessively loaded, the capacitance, or other electrical characteristic, will fall outside the range set by the microprocessor 72 and the microprocessor can then provide a signal to the vehicle control panel 74. In a preferred embodiment the vehicle control panel is an LCD display and the microprocessor indicates a message such as "SAFETY BELT EXCESSIVELY LOADED - REFER TO MANUFACTURER". Alternatively, or in addition to the warning provided to the driver, the microprocessor may store details of excessive safety belt loading events such as date and time and amount of loading so that at the next vehicle service, the service engineer overhauling the vehicle is made aware of the events and is notified as to which safety belts require attention.

[0012] It will be appreciated that the present invention can be applied to any safety restraint, for example, strapping for restraining cargo in a vehicle in addition to conventional vehicle occupant safety belts.

[0013] The advantage of the present invention is that the driver of a vehicle is made aware of a defective safety belt if a safety belt has been excessively loaded as a consequence of a crash or hard braking. Also, the system will detect damage to safety belts due to, for instance, vandalism or wear and tear.

#### Claims

1. A device comprising a vehicle safety belt (10) and a load sensor (24) for sensing load applied to the safety belt, characterised by the sensor comprising means for determining an electrical characteristic of the belt (12) which is affected by load applied to the belt and means for comparing the sensed characteristic with a reference level.
2. A device according to claim 1 characterised in that the means for comparing the electrical characteristic with a reference level determines whether the characteristic falls within a predetermined range.
3. A device according to claim 1 further characterised in that the means for determining the electrical characteristic of the belt (12) comprises first and second electrical contacts on the belt, electrically connected to electrical characteristic sensing means.
4. A device according to claim 3 further characterised in that the first contact is arranged at one end (20) of the belt (12) and the second contact is arranged

at the other end of the belt.

5. A device according to claim 3 further characterised in that one end (20) of the safety belt is wound onto an inertia reel (48) and passes over a bracket (14) above the passenger's shoulder and the other end is secured elsewhere in the vehicle, the first contact comprising a brush contact at the mouth of the inertia reel and the second contact comprising a contact on the said other end. 10

6. A device according to claim 5 further characterised in that a means is provided on the inertia reel (48) to determine the length of belt (12) that has been pulled from the inertia reel. 15

7. A device according to claim 1 further characterised in that calibration means is provided for calibrating the reference level or reference range of the electrical characteristic of the belt (12). 20

8. A device according to claim 7 further characterised in that calibration is conducted on installation of the belt (12) within a vehicle. 25

9. A device according to claim 7 further characterised in that the safety belt (12) is wound on to an inertia reel (48) and brush contacts are used, the calibration means calibrating the reference level of the belt (12) each time the belt is worn by a passenger. 30

10. A device according to claim 9 further characterised in that the safety belt includes a tongue for insertion into a catch of an anchor for the safety belt (12) therein, the calibration means being actuated by insertion of the safety belt (12) tongue into the catch of the safety belt anchor. 35

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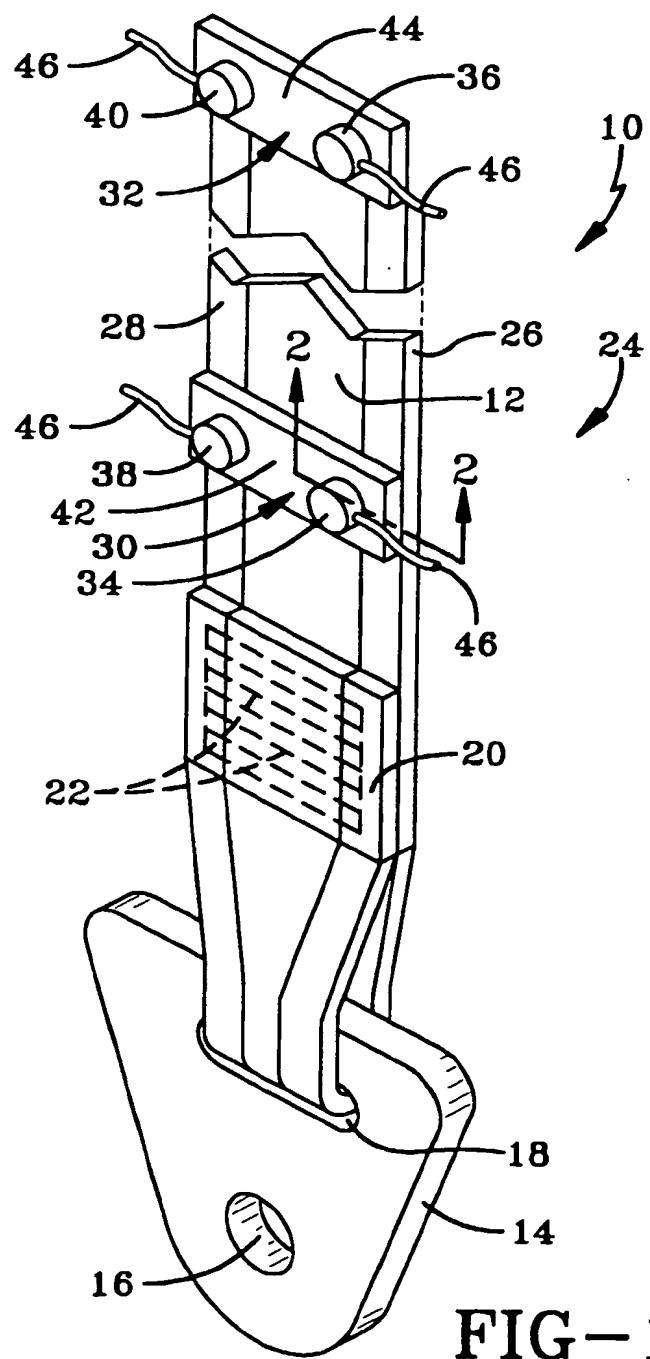


FIG-1

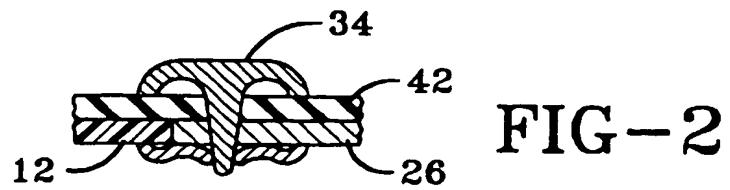


FIG-2

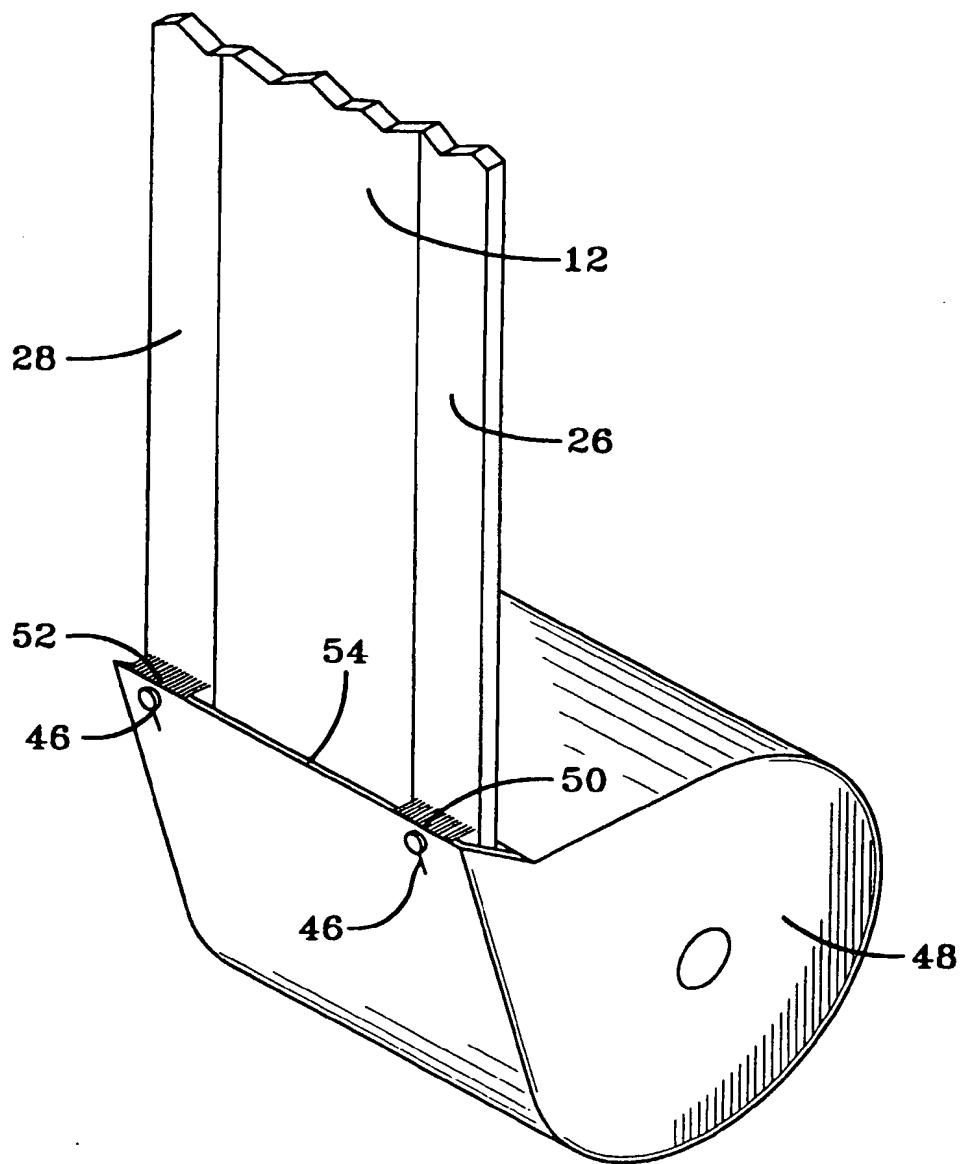


FIG-3

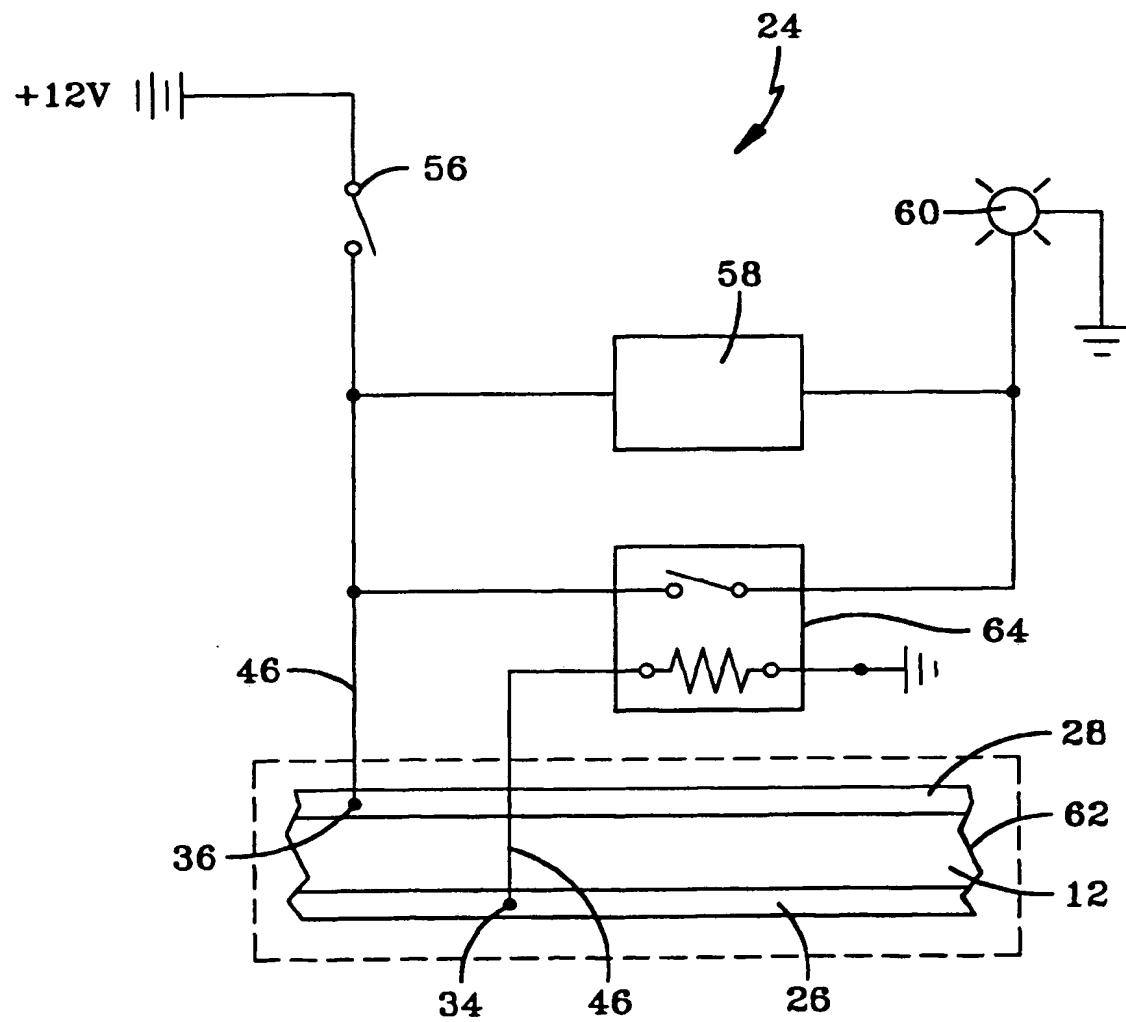


FIG-4

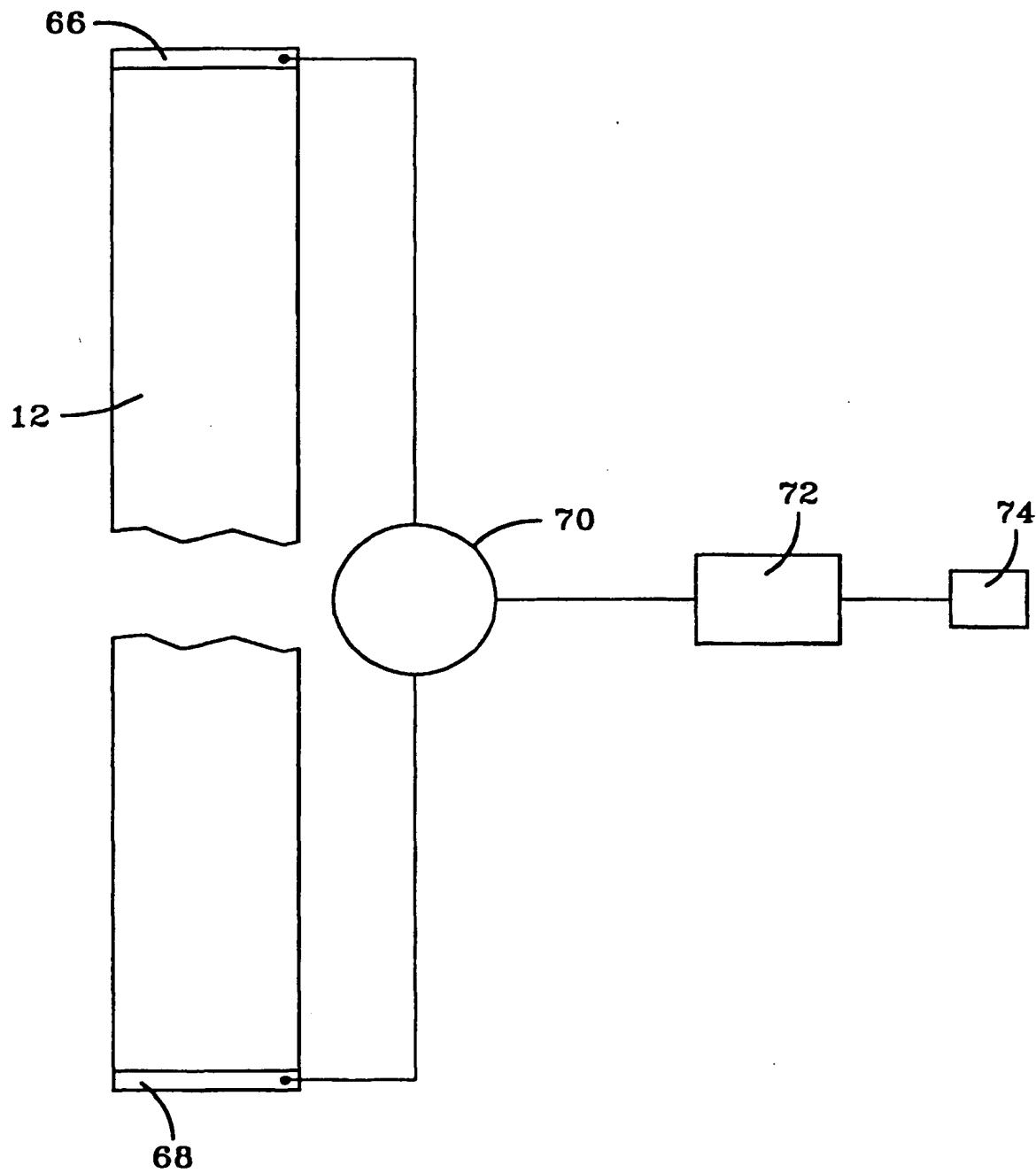
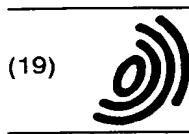


FIG-5



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(11) EP 0 997 358 A3

(12)

## EUROPEAN PATENT APPLICATION

(88) Date of publication A3:  
21.11.2001 Bulletin 2001/47

(51) Int Cl.7: B60R 22/12, B60R 22/48,  
B60R 22/16, B64D 25/06

(43) Date of publication A2:  
03.05.2000 Bulletin 2000/18

(21) Application number: 99202589.0

(22) Date of filing: 06.08.1999

(84) Designated Contracting States:  
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(30) Priority: 29.10.1998 US 182852

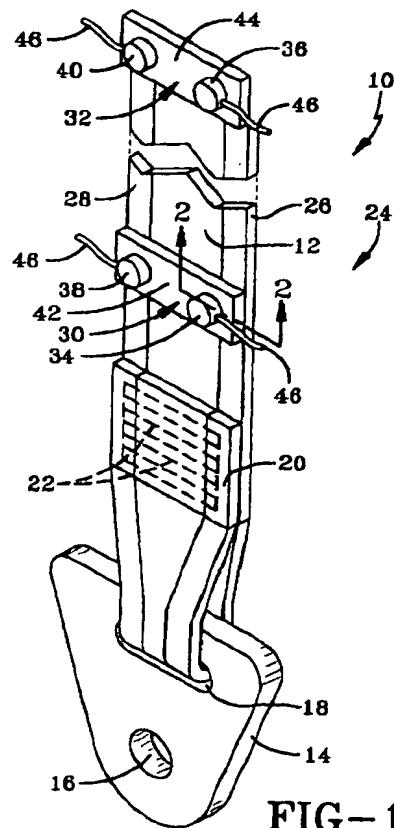
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Application Number  
EP 99 20 2589

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The present search report has been drawn up for all claims					
Place of search	Date of completion of the search	Examiner			
THE HAGUE	1 October 2001	D'sylva, C			
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